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EREP BIMONTHLY PROGRESS REPORT - NUMBER 12

Period: May 16, 1974 - July 15, 1974

INVENTORY OF FOREST AND RANGELAND RESOURCES, INCLUDING FOREST STRESS

Registration No. 418

Contract No. T4106B

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# INVENTORY OF FOREST AND RANGELAND RESOURCES, INCLUDING FOREST STRESS

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### A. Overall Status

#### 1. Manitou, Colorado-range inventory site (161313)

At the Manitou, Colorado site, Driscoll has completed making transparent overlays of five test blocks showing his plot locations. These templates will aid in the interpretation of S-190A and B photographic products. Preliminary measurements with the overlays indicate reasonably good geographic fidelity. Image descriptions of the various vegetation classes are nearly complete.

All training and test site locations have been found on Mission 239 support aircraft photography. Transfer of these points is about one-half completed for Mission 238 EREP photography. Photo image descriptions are being written for interpretation of support photography.

#### 2. Augusta, Georgia-forest inventory site (177512)

We received all imagery from RB-57 Mission 274 that was requested for coverage of our forest inventory site near Augusta, Georgia (Alternate Test Site 177/512). This mission resulted in five flight lines which gave us complete high-altitude coverage of the alternate site. The locations of each photo frame along the flight lines have been located and their principal points marked on 1:250,000 U.S.G.S. maps.

We have not received Skylab 3 and 4 imagery for dual coverage of the Augusta Test Site 177/512. This imagery was ordered on April 10, 1974 and includes the following data:

Skylab Mission	Pass - Track		S190A		S190B	
			Roll	Frame	Roll	Frame
3	25	43/44	39	112 113	88	146 147
4	4	19	52	068 069 070	*	*
4	30	19	70	274 275 276		

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\*data not released for inspection during week of 4/1/74.

A complete set of Skylab 4 imagery was received which covers a small portion of the original Atlanta Test Site. This coverage starts northwest of Birmingham, Alabama and extends to a point south of Columbus, Georgia. We have limited ground data for this area and will not be able to use the imagery at this time.

### 3. Alternate test site-northern California, GT-6, January 27, 1974

At the Redding, California site, <sup>we</sup> received SL-4 data from Pass 93 on ground track 6 in early July. Only about 20% of our site for which we can compute ground reflectance is cloudfree on the S190 photos. We will try to find enough points in this abbreviated area near Whiskeytown Reservoir to make meaningful correlations against satellite radiance. We must do without the red band because Camera Station 5 apparently malfunctioned on frame number 214 even though the Skybet listing indicates the exposure occurrence time preceded the camera malfunction start. The S190B coverage on this descending mode track shows the NW edge of the first frame is approximately 30 km southeast of any part of our site.

In the next reporting period we plan to combine analyzing reflectance data of the Redding, California site. In addition, we will do microdensitometer scans of the S190A photos to obtain relevant density histograms. We will see if the density data fall in the range that is precisely calibratable on our duplicate copy. If not, we may request a special duplicating job on frame 214 only to a lighter or denser B/W copy.

### 4. Black Hills, South Dakota - forest stress site (191312)

All expected data products from SL-4 have been received except for the S190A black and white transparencies.

S190A photographic products - The useful coverage of the Black Hills is north of N44°15'. This area includes most of our intensive study areas, sub block 1 and 2 and the majority of the Lead block. However, the southern one-third of the Spearfish Canyon block is not imaged, and only the northern ten percent of sub block 3 is imaged. All of our forest stress study sites are covered with snow, although there is no snow in the crowns of the conifers. Identification of dead beetle-killed ponderosa pine in the snow areas has little hope for success, however an unexpected benefit is that the new sanitation salvage cutting areas are clearly visible when compared to the SL-2 imagery of the same area. The northeastern part of the Black Hills is free of snow and may be used for additional stress identification work. Also, very good scenes of the experimental watershed (south of Sturgis) and the experimental forest (northwest of Pactola reservoir) will be useful in our study. The Bear Lodge mountain study block used in the analysis of SL-2 and SL-3 imagery is only partially imaged on SL-4 products. The Warren Peaks sub block is to the south of the coverage and most of the area within the study block covered by the imagery has snow-cover or is obscured by thin clouds.

S190B photographic products - The imagery does not cover any part of our forest test site, either in the Black Hills or the Bear Lodge mountains. However, a special area along the Belle Fourche river north of the Bear Lodge mountains, which is of special interest to our soil scientists and geologists in Rapid City, is imaged with only a scattered pall of thin cirrus clouds.

S191 - The 16 mm boresite camera film for pass 85 on January 18, 1974 has arrived and been reviewed. Indications are that the operator/astronaut zoomed in dead center on our test site even though it required going near the side-looking limits of the system. The one-half mile circle of interest at high magnification has considerable snow cover, but there is a possibility that something can be done to filter or clip out the signal from snow in the computer processing. To date we have not received the S191 CCT's for pass 85.

#### B. Recommendations Concerning Decisions Required to Ensure Attainment of Experiment's Scientific Objectives

##### 1. Black Hills South Dakota - forest stress site (191312)

SL-2, S192 tapes - We were informed by the PIMO officer that the June 9, 1973, MSS data for the Black Hills will be rectified (all channels) and delivery date is to be October 18, 1974. The objectives of the S192 analysis can still be attained with the October delivery date, however December 1, 1974 would be the final date that we could accept the CCT's

with the assurance of completing the analysis within the current contract period which ends June 30, 1975.

SL-4, S190A photographic products - Transparencies of the black and white bands for pass 85 have not been received because of a misunderstanding in the product order form. We need the transparencies for a critical part of the analysis, and therefore request that they be sent at the earliest convenience. The frames requested are as follows:

72-142 through 72-151  
71-142 through 71-151  
67-142 through 67-151  
68-142 through 68-151

SL-4, S191 products - Computer compatible tapes for pass 85 on January 18, 1974 have not been received. We have identified the data needed from the pulse correlation index as 1-DPCA-1-85-41-3 (slice 1) and GMT's running from 20:38:20.188 to 20:38:32.210.

#### C. Expected Accomplishments

##### 1. Black Hills, South Dakota - forest stress site (191312)

The color 1:15,840 scale resource photography of the Bear Lodge mountain block and the Warren Peaks sub block will be interpreted 100 percent for mountain pine beetle infestations. The infestations will be counted, placed in proper size classes, and the number of trees in each infestation spot counted. The infestations will be stratified by 1971 attacks which were imaged on SL-2 photography and by 1972 attacks which are on SL-3 imagery.

2. We expect to begin the task of typing the resource photographs in sub block 4 (Warren Peaks), and creating the rectified 1:24,000 scale and 1:62,500 scale type maps which are to be used in the computer assisted processing and in the human interpretation.

#### D. Significant Results, Practical Applications, and Operational Problems

##### 1. Alternate test site-northern California, GT-6, January 27, 1974

While waiting for useable S190A imagery acquired during a late SL-4 pass, we undertook a computation using the SL-2 Sensitometric Data package, JL12-502. It was a calculation of the effective shapes and bandwidths of the S190A bandpasses. These results are a measure of the accuracy of match of our detectors and filters to the wavelength responses of the S190 bands.

The first job was to compute the product function of the various transmittances of the optical elements in front of the S190 films. They are the lens ( $T_L$ ), window ( $T_W$ ) and filter ( $T_f$ ) transmittance values. The products  $T_L T_W T_f = T_t$  were computed at 10 nanometer intervals.

Next, a representative set of film spectral sensitivity values for each original film (S0-022, 2424) was derived. We first plotted several columns of log spectral sensitivity values ( $S$ ) against wavelength for different density levels. As expected with each film, the curves tracked quite well, so that the data at density  $D = 1.0$  could be taken as typical. Also, little spectral difference was seen between the pre- and post-mission sensitometry. To remove overall sensitivity differences, we normalized the eight data sets for S0-022 film and the seven sets for 2424 film. To do this we subtracted all  $\bar{X}$  values in the  $D = 1.0$  column by the peak value which occurred at 450 nm. for S0-022 film and 800 nm. for 2424 film. We then computed the mean value  $\bar{X}$  of the seven or eight sets of normalized  $X$  values, wavelength-by-wavelength (10 nm. intervals). Standard deviations ranged from 0.01 to 0.03  $\text{cm}^2/\text{erg}$  at most wavelengths but reached 0.15 at the long wavelength ends. Finally we computed the products:

$$T_t(\lambda) 10^{\bar{X}(\lambda)} = \bar{S}(\lambda).$$

Figure 1 shows normalized plots of  $\bar{S}(\lambda)$  for the camera stations 1, 2, 5, and 6. Stations 1, 5, and 6 are characterized by relatively gradual gradients on the low wavelength side and peak values very near to the longwave limits. This shape is due entirely to the film curve because the filter functions are all quite square. The characteristic dip at 630-650 nanometers for aerial black and white films is seen in the station 5 bandpass. The curve for station 2 is very symmetrical about its peak value. The curve is not certain beyond 900 nanometers due to incomplete  $x$  data in the JL12-502 package. An integrated bandwidth measurement was calculated by finding the integral  $\int \bar{S}(\lambda) d\lambda$  and dividing by the peak value of  $\bar{S}(\lambda)$ . This proved to be different in some cases from the distance between half power points due to the irregular shapes. Bandwidth information is summarized in Table 1.

Table 1. Measured bandwidths of S190A stations 1, 2, 5, and 6 for SL-2. Units are nanometers.

Station	Design Bandwidth* nm	Actual Half-Power Points	Wavelength at Peak Response	Half-Bandwidth	Integrated Bandwidth
1	700 to 800	713,814	800	101	91
2	800 to 900	805,882	850	77	81
5	600 to 700	601,695	680	94	75
6	500 to 600	517,594	580	77	75

\*EREP, Investigators Information Book MSC - 07874.

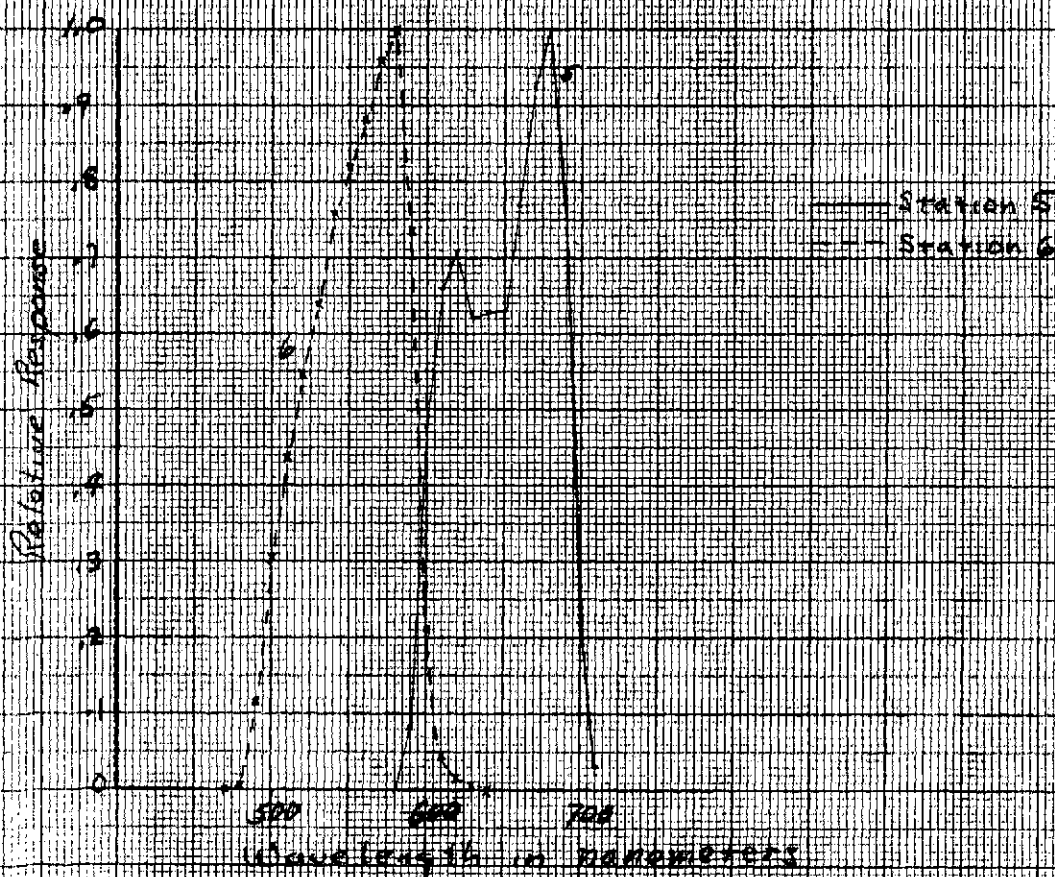


Figure 1: System spectral responses curves S190A, 3-2

Table 2. Measured bandwidths in nanometers of Forest Service airborne radiometry with vidicon and PIN-10 diode sensors

Filter Set	<u>Silicon Vidicon</u>		<u>PIN-10DP</u>	
	Wavelength at Peak Response	Half-Power Points	Wavelength at Peak Response	Half-Power Points
C	720	690,780	710	689,779
D	880	805,965	880	810,956
B	620	605,720	640	605,723
A	540	495,615	550	497,622

In matching the S190A bands for aircraft measurements of scene radiance and reflectance we were constrained by limitations in time and money. Three sets of filters were required--one each for an irradiance meter, radiometer and vidicon imager. The first two employed either a UV-enhanced silicon diode or a PIN-10 diffused silicon diode. The vidicon had an RCA 4532 silicon diode array pickup tube. We selected off-the-shelf absorption glass filters in stock thicknesses to meet the time/cost constraints. For each spectral band a cut-on filter was combined with a long wavelength absorbing glass. Identification of the filter sets with thickness in millimeters shown in parentheses is as follows:

- A - Hoya Y-50 (2.5) + Schott BG-18 (1.0)
- B - Hoya R-60 (2.5) + Hoya HA-30 (3.0) + Schott BG-20 (2.0)
- C - Hoya R-70 (2.5) + Hoya HA-30 (3.0)
- D - Hoya IR-80 (2.5) + Hoya B-370 (2.5)

The bandpass information is summarized in Table 2. Although mismatches between Tables 1 and 2 are apparent, the half-power points for the Forest Service instruments are not very far from the design bandwidths that we had to work with. The only serious difference occurs with set B (station 5) where the radiometer and vidicon will pickup some energy from the strong infrared reflection band of green vegetation, which begins at about 700 nm. The radiometers are calibrated against average spectral irradiance for the band to compensate, in part, for the mismatch in bandwidths.

Another compensation made during this reporting time-period was the determination of solar altitude values for the times and locations of the Forest Service radiometric underflights. Corrections had to be made in the sun-angle effects on the irradiance probe built into the roof of the aircraft.

A FORTRAN program, DENRAD, was written to use in computing the radiance for a given density value as measured on the S190A stations 1, 2, 5, and 6. The inputs are camera f-number, exposure time, target relative spectral radiance, lens-filter-window transmittance, and spectral sensitivity of the film. The formulation of the equation is given in JL12-502,503.

E. Travel Plan-July 16 to September 15, 1974

We have no plans to travel during this period.